MATHEMATICS 1 FOR BE-CSE/IT IMPORTANT STUDY MATERIAL BY CU UPDATES

PREAPED BY ANKUL KUMAR

📘 **Mathematics 1 – Important Questions**

✨ **Unit I – Basics of Calculus & Matrices**

🔹 **2 Marks**

- Define a matrix. Give examples of different types of matrices.
- What is an orthogonal matrix?
- Define rank of a matrix.
- State Cayley-Hamilton theorem.
- Write the condition for consistency of a system of linear equations.

🔹 **5 Marks**

- Reduce the given matrix to echelon form and find its rank.
- Show that the product of two orthogonal matrices is orthogonal.
- Solve a system of linear equations using matrix method.
- Find eigenvalues and eigenvectors of a (2 \times 2) matrix.
- Test the linear dependence of given vectors.

🔹 **10 Marks**

- Derive Cayley-Hamilton theorem (statement only, proof not required). Use it to find the inverse of a matrix.
- Solve a system of 3 linear equations using matrices and discuss consistency.
- Diagonalize a given matrix and find its modal matrix.
- Apply elementary transformations to reduce a matrix to echelon form and hence find its rank.

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✨ Unit II – Vector Space & Linear Transformations

🔹 2 Marks

- Define vector space with an example.
- What is the dimension of a vector space?
- Define kernel of a linear map.
- State the rank-nullity theorem.

🔹 5 Marks

- Find basis and dimension of the vector space spanned by given vectors.
- Determine whether the given set of vectors is linearly independent.
- Find the matrix associated with a given linear transformation.
- Show that the composition of two linear maps is a linear map.

🔹 10 Marks

- Find the range and kernel of a given linear transformation and verify rank-nullity theorem.
- Derive the relation between rank and nullity of a linear transformation.
- Apply Gram-Schmidt orthogonalization process to obtain an orthonormal basis.
- Find the inverse of a linear transformation and verify with an example.

✨ Unit III – Differential Equations

🔹 2 Marks

- Define order and degree of a differential equation with examples.
- Write the general form of Leibniz's linear differential equation.
- State Bernoulli's differential equation.
- What is an exact differential equation?

🔹 5 Marks

- Solve (\frac{dy}{dx} + y = e^x).

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- Solve Bernoulli's equation (\frac{dy}{dx} + y = y^2).
- Solve an exact differential equation by finding the integrating factor.
- Find the complementary function and particular integral of (y'' + y = \sin x).

🔹 **10 Marks**

- Solve (y'' + 4y' + 4y = e^{-2x}) using method of variation of parameters.
- Solve Cauchy's homogeneous linear equation (x^2y'' + xy' - y = 0).
- Solve Legendre's linear equation ((1-x^2)y'' - 2xy' + n(n+1)y = 0).
- Derive the method of variation of parameters and solve a numerical example.
- Solve simultaneous linear differential equations with constant coefficients.

📝 **Strategy for Exam Prep**

- **2 Marks** → Focus on definitions, statements, and short properties.
- **5 Marks** → Practice small derivations and numerical problems.
- **10 Marks** → Prepare full derivations, proofs, and complete solutions with examples.

Got it ✅ — you want **12 purely numerical/problem-solving questions** (no theory/definitions) covering **all three units** of your syllabus. Here's a carefully selected set:

📘 **Mathematics 1 – Numerical Problem Set (12 Questions)**

🔹 **Unit I – Matrices (4 Questions)**

1. Reduce the matrix
   [A = \begin{bmatrix}1 & 2 & 3 \ 2 & 4 & 6 \ 1 & 1 & 1\end{bmatrix}]
   to echelon form and find its rank.
2. Solve the system of equations using matrix method:
   [x + y + z = 6,\quad 2x + 5y + 7z = 18,\quad 2x + y - z = 2]
3. Find the eigenvalues and eigenvectors of
   [A = \begin{bmatrix}4 & 1 \ 2 & 3\end{bmatrix}]

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4. Using Cayley-Hamilton theorem, find the inverse of
   [A = \begin{bmatrix}2 & -1 \ 1 & 0\end{bmatrix}]

- **Unit II – Vector Spaces & Linear Transformations (4 Questions)**

5. Determine whether the vectors
   ((1,2,3), (2,4,6), (3,6,9))
   are linearly independent.
6. Find the basis and dimension of the vector space spanned by
   ((1,0,1), (2,1,0), (3,1,1)).
7. Let (T: \mathbb{R}^2 \to \mathbb{R}^2) be defined by
   (T(x,y) = (x+2y, 3x+y)).
   Find the matrix associated with (T).
8. Apply Gram-Schmidt orthogonalization to the vectors
   ((1,1,0), (1,0,1))
   to obtain an orthonormal basis.

- **Unit III – Differential Equations (4 Questions)**

9. Solve the first-order linear differential equation:
   [\frac{dy}{dx} + y = e^x]
10. Solve Bernoulli's equation:
    [\frac{dy}{dx} + y = y^2]
11. Solve the second-order differential equation:
    [y'' + 4y' + 4y = e^{-2x}]
12. Solve Cauchy's homogeneous linear equation:
    [x^2y'' + xy' - y = 0]

Perfect! Let's design a **predictable sample paper** for **Mathematics 1 (EST)** based on your syllabus. I'll structure it exactly as you requested: **2 marks – 5 questions, 5 marks – 4 questions, 10 marks – 4 questions.**

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📘 Mathematics 1 – Sample Paper (EST)

Section A – 2 Marks (Answer any 5)

1. Define rank of a matrix with an example.
2. State Cayley-Hamilton theorem.
3. Define kernel of a linear transformation.
4. Write the general form of Bernoulli's differential equation.
5. Define order and degree of a differential equation with examples.

Section B – 5 Marks (Answer any 4)

6. Reduce the matrix
   [A = \begin{bmatrix}1 & 2 & 3 \ 2 & 4 & 6 \ 1 & 1 & 1\end{bmatrix}]
   to echelon form and find its rank.
7. Find eigenvalues and eigenvectors of
   [A = \begin{bmatrix}4 & 1 \ 2 & 3\end{bmatrix}]
8. Determine whether the vectors ((1,2,3), (2,4,6), (3,6,9)) are linearly independent.
9. Solve the differential equation
   [\frac{dy}{dx} + y = e^x]

Section C – 10 Marks (Answer any 3)

10. Using Cayley-Hamilton theorem, find the inverse of
    [A = \begin{bmatrix}2 & -1 \ 1 & 0\end{bmatrix}]
11. Find the range and kernel of the linear transformation
    (T(x,y) = (x+2y, 3x+y))
    and verify the rank-nullity theorem.
12. Solve the differential equation
    [y'' + 4y' + 4y = e^{-2x}]
13. Solve Cauchy's homogeneous linear equation
    [x^2y'' + xy' - y = 0]

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